# Development & Evaluation of Active Packaging Film Incorporating Gallic Acid from Onion Peels for Sprouted Pulses

SHORT SYNOPSIS

*Submitted in partial fulfillment of the requirement of the degree of*

DOCTOR OF PHILOSOPHY

*to*

*Manav Rachna International Institute of Research and Studies (Deemed to be University)*

*by*

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## SCHOOL OF ALLIED HEALTH SCIENCES

### Certificate

I hereby declare that the short synopsis Titled **"Development & Evaluation of Active Packaging Film Incorporating Gallic Acid from Onion Peels for Sprouted Pulses"** being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Nutrition & Dietetics under the School of Allied Health Sciences of Manav Rachna International Institute of Research & Studies, Faridabad during the academic year 2024-25. It is a bona fide record of original work carried out under the supervision of Dr. Gurseen Rakhra & co-supervision of Dr. Lakhvinder Kaur. It has not been submitted in full or part to any other university or institute for a degree or diploma. Further, it is certified that the short synopsis is plagiarism-free and proof has been submitted.

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## ABSTRACT

Food packaging is an integral part of the environment. Since a lot of plastic packaging not only increases the carbon footprint but also amplifies the environmental degradative changes. Sprouted pulses are a rich source of phytonutrients and are more susceptible to spoilage due to their higher moisture content & respiration rates. Henceforth, they should be packaged sustainably so that they do not contract any form of microbial contamination. Sprouted pulses are packed in single-use plastic packaging, often observed in shopping malls, supermarkets, and online grocery portals. The proposed study will illustrate a sustainable alternative to single-use plastic packaging. This research study will envisage the development of an active packaging film by the utilization of gallic acid extracted from onion peels. Various chemical reactions occur in the context of plastics being used as packaging material for sprouted pulses. Gallic acid is utilized to formulate packaging films that are biodegradable and healthy for the consumers of sprouted pulses. The films would be assessed for different physical, permeability, and functional parameters.



**Keywords:** Active packaging, sprouted pulses, spoilage, Gallic acid, sustainable solution, etc

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# INTRODUCTION

Packaging sprouted pulses with plastic sheets is harmful to consumers due to various reasons. It has been noted that some single-use plastic sheets are laced with coatings and additives. This can be harmful to the environment and also to the people consuming the packaged sprouted pulses. Plastic is a non-breathable item, and this aspect can lead to the shortening of the shelf life of food products such as sprouted pulses. It has also been observed that single-use plastic sheets do not provide a longer shelf life and can start to degrade or get discoloured over time. Plastic sheets for packaging may be mixed with chemicals that can be highly harmful to the people consuming food products packaged with them.

Globally, fruits and vegetables are consumed as raw, processed, or as an additive, accounting for approximately 50% of total food wastage. India is also the 2nd largest producer of onion in the World (Bains et al., 2023). Among the fruits and vegetables, onion is well known for its potential bioactive components; however, peels of onion are a major concern for the environmental health and food industries. Effective utilization methods for valorizing the onion peel are needed to develop value-added products that are more eco-friendly, cost-effective, and sustainable (Choi et al., 2015)

Gallic acid is a phenolic acid, which is found in vegetables and fruits. Humans have consumed Gallic acid for centuries. Gallic acid's health benefits include antioxidant, antimicrobial, anti-inflammatory, and anti-cancerous properties. Gallic acid possesses some biologically degradable chemicals that can be helpful for people consuming sprouted pulses. Gallic acid-based packaging films are not toxic like plastic-based packaging sheets. Gallic acid is a biodegradable element and producing it from onion peels adds to its paradigms of being eco-friendly, unlike synthetic sheets (Santos et al., 2021).

Plastic waste production has reached alarming levels in recent decades, driven by the rise of single-use plastics and insufficient waste management practices. Millions of tons of plastic are produced each year, with a significant portion ending up in landfills, oceans, and natural habitats. This waste poses severe environmental impacts, including the degradation of ecosystems, harm to wildlife through ingestion or entanglement, and the leaching of toxic chemicals into soil and water sources. Transitioning to sustainable food packaging is one essential step for protecting the

environment, promoting health, and meeting the evolving demands of consumers and regulators.

## REVIEW OF LITERATURE

### Reason for Packaging Sprouted Pulses

Sprouted pulses kept at room temperature can lead to unhygienic conditions, which is a major challenge. Recognizing the necessity for them to be packaged sustainably offers a hygienic and natural solution to store them. Sprouted pulses are extremely effective and beneficial for people of all age groups. As per Luzi et al. (2019), sprouted pulses have to be kept airtight. Another aspect in this context is that packing these pulses with eco-friendly substances such as Gallic acid films can lead to the preservation of natural nutrients in them. It is also useful for consumers to easily carry and store them without worrying about spillage issues. Packing with films derived from Gallic acid extracted from onion peels can serve various benefits along with offering sustainable packaging paradigms.

In the recent periods, new sorts of lifestyles are being led by most of the populations across the globe. There is also a lack of time for people to conduct domestic preparations, which has been accompanied by an evolution of the framework of food consumption and the dismantling of meals. Hence, the consumption of packaged sprouted pulses has grown rapidly due to the aspect that consumers are affluent but possess lack of time (Moradi et al., 2023). Plastic sheets are used for the processing and packaging of sprouted pulses. The usage of single use plastic in food packaging is reported to have people consuming microorganisms that are present in them.

### Need for Gallic Acid Packaging Films

Plastic is a non-degradable item and hence it leads to land pollution. Sprouted pulses should be packaged with biodegradable substances so that the biochemical changes within this food item can be stopped. Gallic acid extracted from onion peels can be processed as a packaging film to combat the degradation of the quality of sprouted pulses. According to Thivya et al. (2022), it is also helpful to reduce the microbiological reactions in sprouted pulses along with reducing physical and chemical spoilage of the same. Packaging films made from Gallic acid can be highly helpful in maintaining an optimum temperature to preserve sprouted pulses.

These films have the capability of increasing oxygen levels in the pulses and also reduces carbon dioxide in them (Gulati et al., 2023). This leads to maintaining the quality of these pulses and providing an optimal temperature so that sprouted pulses can be preserved for a long time.

Packaging of sprouted pulses with Gallic acid films aids to protect them from any form of damage so that they reach the consumers in good condition. It also extends the shelf life of sprouted pulses by maintaining the appropriate humidity levels and temperature. Kızıl (2023) has stated incorporation of Gallic acid derived from onion peels into packaging films increases antimicrobial properties. Gallic acid has oxygen-scavenging and antioxidant prospects in it. It reduces the chances of rotting, thus leading to high-quality sprouted pulse products for people. Gallic acid's sensitivity to various environmental prospects holds a concrete potential to formulate smart food packaging films. Gallic acid is also termed 3, 4, 5-trihydroxybenzoic acid, which is usually found in onion peels and various other sources such as tea leaves, gallnuts, and sumac (Devi et al., 2024).

**Properties of Gallic acid**

Food packaging has contributed to enormous plastic waste which has led to ecological degradation and environmental pollution. Plastic and cellophane packaging has also led to an increment in greenhouse gas emissions, chemical risks, and microplastic accumulation. Hence, it has become necessary to produce biodegradable packaging films from functional sources (Thivya et al., 2023). Food contaminated with microbes increases the risk of food poisoning and is more prone to spoilage. According to Thivya et al. (2021), Gallic acid protects sprouted pulses from various bacterial paradigms' growth through various mechanisms including changing the metabolism and structure of the membrane, thus inhibiting the formulation of biofilm due to its antibacterial characteristics.

Gallic acid also possesses antifungal properties, which help preserve sprouted pulses for a long period. The spoilage of sprouted pulses is usually caused due to microbial growth, which threatens the health of humans. Gallic acid made from onion peels has anti-microbial features, thus preventing sprouted pulses from being spoiled (Bhargava et al., 2020). Packaging films made from Gallic acid reduce oxidative stress, as Gallic acid is a powerful antioxidant. Oxidative stress is caused by a wide array of environmental parameters. Therefore, it can be stated that the development of packaging films from onion peels extracted from Gallic acid could have various benefits.

## RESEARCH GAPS

Studies conducted on the negative impact of plastic sheets in various prospects have paved the way for researchers to conduct more research on the avenues to combat this issue. The number of research studies focusing on extraction techniques of Gallic acid from onion peels is also limited. The gap in research is also because researchers have not illustrated the benefits of Gallic acid and how it can be highly helpful in formulating food packaging films.

However, the prior conducted research studies do not portray many alternatives to plastic sheet packaging that can be produced and utilized practically in a cost-effective manner (Wang et al., 2022).

## DESCRIPTION OF TOPIC

Sprouted pulses are generally perishable items when exposed to open air, resulting in loss of sensory properties along with loss of texture of tissues and degradation of cell membranes (Boccalon et al., 2022). When pulses are sprouted, certain enzymes present in the pulses are exposed to air, thus resulting in oxidation. Apart from this, the growth of microorganisms like bacteria leads to the spoilage of the product. Therefore, food packaging and storage have become essential tools for increasing the shelf-life of sprouted pulses' (Stoica et al., 2023). Owing to these reasons, biodegradable and edible food packaging materials are being developed by various food packaging companies so that produce can be preserved for a long time. Singh et al. (2022) have mentioned that in the domain of food packaging, maintaining relative humidity (RH) for a film is a crucial factor for its barrier and mechanical properties.

Contrary to plastic packaging sheets, Gallic acid packaging films would prove to modify their barrier and mechanical features in high moisture environments, especially in fresh-sprouted pulses. As per Amin et al. (2022), some parameters play a vital role in the application of food packaging. The first parameter is the effect of an element termed as plasticizer. A plasticizer can be stated as an additive that is utilized to increase a packaging film's elasticity. Plasticizers are a crucial or significant class of non-volatile elements having a molecular weight of around 300 to 600 kDa.

A plasticizer can change the chemical and/or physical properties of materials when they are added to it. This leads to improvement of the mechanical prospects such as the tensile strength, and flexibility of the packaging films. Plasticizers also improve the barrier

characteristics such as the permeability of oxygen and water vapor along with optical characteristics such as opacity and glossiness (Sani et al., 2023). Presently, a wide array of plasticizers is being utilized in various applications in the development of films used for food packaging. Glycerol, water, mannitol, sorbitol, and sucrose are the commonly utilized plasticizers in the food packaging industry.

The next parameter is the effect of cross-linkers. Cross-linkers are utilized for improving the rigidity, thermos ability, mechanical and barrier strength, and water resistance of packaging sheets. Cross-linker's effect on fresh-sprouted pulses aids in modifying the storage modulus, transition temperature, and tensile strength. Another parameter is the effect of temperature; RH, pH, time, and temperature are crucial factors in improving the shelf life and quality of food products. Heating food at high temperatures can result in protein-to-protein cross-linkage. Other chemical reactions also occur while heating food at high temperatures. The development of various forms of microstructure during the gelation process results in the formulation of homogenous and smooth structures of packaging films. Depending on the pH of a film, the gel formulation of packaging sheets differs in its functional characteristics due to the presence of hydrophobic interaction, hydrogen bonding, disulfide linkage\ and electrostatic interaction of protein.

In 2021, around 390 million tons of plastics had been produced globally. The food packaging industry is one such industry where a lot of plastic is needed. In the current timeframe, eco-friendly components are being utilized for the preparation of packaging films. There are various polymeric substances used for the formation of packaging films in the food packaging sector. Most polymeric substances are less costly than plastic films and possess appropriate mechanical, transportation, and physical properties so that they can be utilized for the packaging of food. Thivya et al. (2021) have stated that there is a growing interest in lowering the environmental impact of plastic packaging as well. Hence, novel materials are being studied by experts and researchers so that these materials can be utilized for food packaging.

## PROBLEM STATEMENT

Plastic sheets used for food packaging are leading to serious problems for the environment and people's health. Environmental experts are highly concerned due to this. More research is being conducted on how eco-friendly materials can be used for food packaging.

Packaging films made from Gallic acid extracted from onion can be a good alternative to plastic packaging (Dilucia et al., 2020). It can eradicate various environmental issues, as it is biodegradable and preserves food quality in sprouted pulses, thus benefiting the health of people.

**Study Hypothesis:**

H0: The active packaging film with gallic acid incorporation has no impact on the functional properties of the developed film and the shelf life of the sprouted pulses.

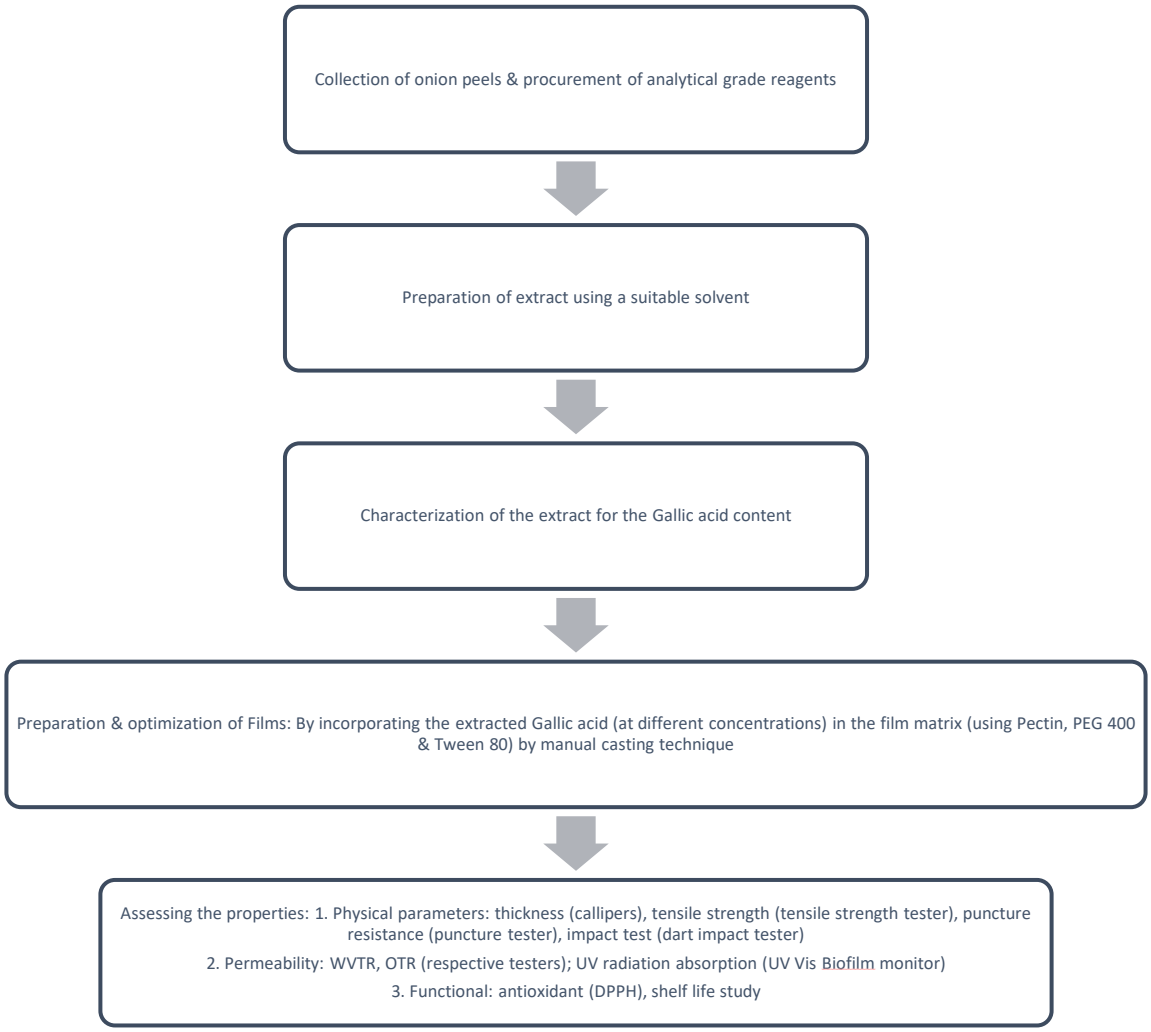
H1: The active packaging film with gallic acid incorporation has a positive impact on the functional properties of the developed film and the shelf life of the sprouted pulses.

**AIM:** The study aims to formulate an active packaging film incorporating gallic acid (extracted from onion peel waste) and analyze the physical, permeability & functional properties of the film on sprouted pulses.

## RESEARCH OBJECTIVES

1. To extract & characterize the gallic acid from onion peels
2. To formulate & optimize the active packaging films using Gallic acid extract
3. To assess the physical, permeability & functional properties of the developed packaging film on sprouted pulses

# METHODOLOGY FLOWCHART


Collection of onion peels & procurement of analytical grade reagents
Preparation of extract using a suitable solvent
Characterization of the extract for the Gallic acid content
Preparation & optimization of Films: By incorporating the extracted Gallic acid (at different concentrations) in the film matrix (using Pectin, PEG 400 & Tween 80) by manual casting technique
Assessing the properties: 1. Physical parameters: thickness (callipers), tensile strength (tensile strength tester), puncture resistance (puncture tester), impact test (dart impact tester)
2. Permeability: WVTR, OTR (respective testers); UV radiation absorption (UV Vis Biofilm monitor)
3. Functional: antioxidant (DPPH), shelf life study

## DETAILED METHODOLOGY

### Procurement & preparation of raw materials

1. The onion peels would be collected and stored under ambient storage conditions.
2. Suitable analytical grade reagents (Ethanol, Pectin, PEG 400 & Tween 80 will be procured from the vendor
3. The onion peels will be cleaned and dried at 30-45˚C for 24-48 hours. The resultant product will then be ground into fine powder using an electronic mixer grinder.

### Extraction & Quantification of Gallic acid

4. Suitable solvent extraction technique will be employed to yield the gallic acid extract (GAE). The extract would be concentrated using rotary vacuum evaporator. The concentrated extract would be stored under deep freezer (-10˚C) until further use.
5. The extract would be characterized for the Gallic acid content using HPLC technique.

### Preparation of Active packaging film

6. Incorporation of gallic acid extract (GAE) (at different concentrations) in film matrix (constituted by pectin, PEG 400 & Tween 80) by manual casting technique.

### Assessment of Film Characteristics

7. Assessment of the film's physical parameters would be done by analyzing thickness (using calipers); tensile strength (tensile strength tester), puncture resistance (puncture tester), impact test (dart impact tester)
8. Permeability of the film will be assessed by Water Vapor Transmission Rate (WVTR), OTR (Oxygen Transmission Rate) (Coulometric sensor); UV radiation absorption (UV Vis Biofilm monitor)
9. The Functional properties of the film will be done by checking the antioxidant (DPPH) activity and by conducting a shelf life study.
10. Appropriate software tools would be used to assess and analyze the data (SPSS).

## PROPOSED OUTCOME

This research study will help us know about the properties of Gallic acid. The research will also portray the procedures by which Gallic acid; can be extracted from the onion peels. This will lead to the manufacturing of food packaging films with Gallic acid. The usage of Gallic acid in food packaging film is expected to preserve the quality of sprouted pulses (Łopusiewicz et al., 2021). Therefore, this research study will help replace single-use plastics with Gallic acid packaging films. This aspect has the potential to eradicate the harmful effects of non-biodegradable substances, as packaging films from Gallic acid extracted from onion is biodegradable. It will lead to lesser land pollution along with offering a healthy ecosystem across the globe.

The problem with plastics used in the food industry is increasing with time. Hence, there should be a unique solution to this problem so that environmental pollution can be ceased along with offering a healthy substitute for packaging sprouted pulses (Bains et al., 2023). There are some benefits that the research can offer to the audience. Firstly, the audience can be made aware of the harmful impact of plastic films, which are usually used to pack foodstuffs, especially sprouted pulses. Secondly, the research will portray the benefits of packaging films made from Gallic acid. It will make the audience more accepting of this change and hence they can enjoy the various positive prospects of the change.

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Researcher: DIVYA PURI. Registration Number: 21/PhD/005

Supervisor: DR. GURBEEN RAKHRA Department: NUTRITION & DIETETICS

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# Development & Evaluation of Active Packaging Film Incorporating Gallic Acid from Onion Peels for Sprouted Pulses

SHORT SYNOPSIS

*by*

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## ABSTRACT

Food packaging is an integral part of the environment. Since a lot of plastic packaging not only increases the carbon footprint but also amplifies the environmental degradative changes. Sprouted pulses are a rich source of phytonutrients and are more susceptible to spoilage due to their higher moisture content & respiration rates. Henceforth, they should be packaged sustainably so that they do not contract any form of microbial contamination. Sprouted pulses are packed in single-use plastic packaging, often observed in shopping malls, supermarkets, and online grocery portals. The proposed study will illustrate a sustainable alternative to single-use plastic packaging. This research study will envisage the development of an active packaging film by the utilization of gallic acid extracted from onion peels. Various chemical reactions occur in the context of plastics being used as packaging material for sprouted pulses. Gallic acid is utilized to formulate packaging films that are biodegradable and healthy for the consumers of sprouted pulses. The films would be assessed for different physical, permeability, and functional parameters.

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**Keywords:** Active packaging, sprouted pulses, spoilage, Gallic acid, sustainable solution, etc

# Untitled

by Divya Puri

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| 28,950 | 4,068 | 290 | 16 min 16 sec | 31 min 17 sec |
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| 1 | Wordy sentences | |
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| | | |
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